NUCLEAR ENERGY RESEARCH INITIATIVE

Managing Model Data Introduced Uncertainties in Simulator Predictions for Generation IV Systems via Optimum Experimental Design

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Collaborators: Idaho National Laboratory, Argonne National Laboratory

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Program Area: Generation IV

Project Description

This research project addresses the understanding and management of uncertainties in modeling and simulation software due to the uncertainties inherent in the physical data utilized in the computer codes. This research will address the quantification of uncertainties and develop an optimum design for experiments to reduce these uncertainties. It will incorporate aspects of sensitivity analysis, uncertainty analysis, inverse theory, and mathematical optimization. To validate the capabilities being developed, the optimum design will be applied to a Generation IV nuclear energy system concept.

Specifically, this project will determine model uncertainties of key design attributes originating from the uncertainty associated with nuclear data of a proposed Generation IV nuclear energy system. An experiment will be designed and optimized to reduce these model data uncertainties, utilizing the Idaho National Laboratory Zero Power Physics Reactor (ZPPR) facility as a test basis. Finally, a simulated ZPPR experiment for the optimum design will be completed to obtain pseudo-observable core parameters, which will be utilized to calculate values of the adapted nuclear data. By understanding and quantifying uncertainties of complex engineering systems, appropriate design margins can be applied and rational cost-benefit decisions made.

Workscope

The following key activities comprise the project workscope:

- Determine which Generation IV core design to evaluate
- Define key design limiting responses of Generation IV core and design parameters/ instrumentation options for ZPPR core
- Establish neutronic models for Generation IV and ZPPR cores
- Develop cost models
- Evaluate key responses of the Generation IV core and sensitivity coefficients for ZPPR
- Develop simulation of ZPPR core and determine nuclear data matrix
- Determine matrix of key design limiting responses of Generation IV core
- Complete optimization of ZPPR core composition and instrumentation using virtual and design basis core models